

# PRELIMINARY OBSERVATIONS ON THE IMPORTANCE OF A LARGE COMMUNAL ROOST OF WINTERING HARRIERS IN GUJARAT (NW. INDIA) AND COMPARISON WITH A ROOST IN SENEGAL (W. AFRICA)<sup>1</sup>

ROGER CLARKE<sup>2</sup>

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The largest communal roost of wintering harriers in the world reported in recent times occurred in the grassland at Velavadar National Park, Gujarat, north-west India. It consisted of up to 2000 birds, mainly Montagu's Harriers *Circus pygargus* (about 75%) and Pallid Harriers *Circus macrourus* (about 20%) and has been known since the mid 1980s. Pre-roosting, roosting and post-roosting behaviours are described. About 30% of the harriers present were adult males, but only one dark morph Montagu's Harrier was recorded. Foraging behaviours are described; the Montagu's Harriers fed mainly on locusts in shrublands and cotton fields and male Pallid Harriers were observed hunting small birds in grassland. Of 134 pellets collected at the roost, 60% contained locust remains, principally of the Tree Locust *Anacridium rubrispinum*. It was calculated that the harriers attending the roost probably consumed more than 1.5 million locusts each winter. The rest of the prey remains in the pellets were mainly of small birds, principally larks, although the remains of a few mammals and reptiles also occurred. The roost is compared to one found in Senegal, West Africa.

## INTRODUCTION

More than 1500 Harriers were counted roosting at Velavadar Blackbuck Sanctuary and National Park, Gujarat, north-west India in November 1991 (W.S. Clark *in litt.*). This appears to be the largest roost of harriers recorded in the literature since nineteenth century observations of thousands of Montagu's Harriers roosting after the breeding season and before migration at a marsh in the west of France (Barbier Montault 1838). The great majority of harriers at Velavadar were Montagu's Harriers *Circus pygargus* (about 75%) and Pallid Harriers *C. macrourus* (about 20%), but very few Marsh Harriers *C. aeruginosus* and one or two ringtail Hen Harriers *C. cyaneus* were also present. This paper details observations during two visits to Velavadar, on 1-6 February 1992 and 25-31 January 1993. On my first visit I collected 134 pellets from two settling areas which were attracting about 500 and 300 birds respectively at the time. The results of my analysis of the pellets and observations of foraging and roosting behaviour are given below and compared with observations on harriers and

the results of analysis of 113 pellets collected at a roost of about 1000 Montagu's Harriers in late December 1988 and early January 1989 near M'bour, Senegal, West Africa (Cormier and Baillon 1991).

## ROOST CATCHMENT AREAS

The Indian roost site (22° North) is in a remnant of grass plain occupying the northern half of 17.38 sq. km of land preserved as a National Park in 1976 to conserve the Blackbuck *Antelope cervicapra*. The Park is situated in a semi-arid area of alluvial plain known as the 'Bhal' (reputed to mean 'forehead', i.e. a bare, open landscape), on the western shore of the Gulf of Khambhat (Arabian Sea). Some land between the Park and the Gulf of Khambhat (20 km away) is a saline wasteland irregularly inundated by the sea in the monsoon, but much of the surrounding plain consists of shrublands of Mesquite *Prosopis chilensis* and large arable fields, in winter, mainly growing a special strain of cotton not requiring irrigation. A high proportion of the fields were ploughed at the time of my visits and cotton was being harvested. In the day, many Montagu's Harriers were observed hunting over the cotton fields.

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<sup>2</sup>New Hythe House, Reach, Cambridge CB5 0JQ, U.K.

The African roost site (14° North) is situated close to the Atlantic coast in fairly flat, open savannah with abundant ground vegetation and a few trees. The harriers hunted around brackish lagoons, in savannah and dunes, not over crops.

#### ROOST SITES

The Indian Harriers roosted in a *Dichanthium*-dominated grass community about 40 cm tall in large, totally open fields which had been used as hay plots and were now maintained just by shrub clearance, although bordered by hedges of shrubs, especially *Prosopis chilensis*.

The African roost was in ground vegetation in an area of savannah with some trees, principally *Ziziphus mauritiana*, and with scattered humps of old termite mounds 1-1.5 m high. Domestic grazing herds, mainly of goats and cattle, crossed the site by day, but the ground vegetation was still quite dense.

#### PELLET ANALYSIS METHODS

For the purposes of this paper, the term 'locust' includes large grasshoppers. Pellets from India containing only locust or a mix of locust and reptile remains were dissected dry. Pellets at least partly made up of bird or mammal remains were dissected wet and the remains were washed and allowed to dry. Pellets of pure locust remains were very fragile and liable to break in two on the ground or when collected. The collection comprised 46 part pellets, which were counted as 23 whole pellets, and 111 whole pellets to give the equivalent of 134 pellets. The locusts were identified from the manual issued by the Centre for Overseas Pest Research (1992) and specimens in the collection of the Bombay Natural History Society. The number of locusts in each pellet was taken as the highest number represented either by mandibles or by ovipositor valves. Care had to be taken to identify dorsal and ventral pairs of ovipositor valves to arrive at the correct number of female locusts that they represented. Counts of locusts from mandibles were based on the highest number of right or left mandibles in the pellet. Bird remains were identified by matching against reference collections. Larks were counted by

means of bill parts or hind claws. Pigeons and doves were recognised from their white down and feather fragments. Sparrows were recognised and counted by the palatal thickenings from their bills. Bird remains which could not be identified were counted as one bird per pellet, but were few in number. Reptiles could not be enumerated or identified since remains were almost entirely loose scales. One pellet contained a lizard jaw. Mammals were identified from their fur and teeth. Indian Bush Rat *Golunda ellioti* and Gerbil *Tatera indica* teeth were identified from the early, but accurate illustrations in Blanford (1888). Mice and rats were identified from hair, jaws or incisors. Lagomorph fur was confirmed by microscopic examination of the medulla (Koppikar and Sabnis 1976).

#### OBSERVATIONS

**Roosting, pre-roosting and post-roosting behaviour:** The number of harriers using the Velavadar roost fluctuated during each winter. In both 1991 and 1992, large counts (1500-2000) were made in November/December. Later in each winter, numbers dropped in January/February (800 birds in early February 1992 and 600 declining to 300 in late January 1993). The full seasonal pattern is yet to be established, but it seems likely that the roost is reduced in size from midwinter because birds pass south before coming back on return migration. Further large roosts are known or suspected south to Andhra Pradesh (southeast India) and research is required to ascertain whether they peak later (A. Mulchandani, pers. comm.). Migration of harriers from the direction of Gujarat through the Western Ghats has been observed in the past (Khacher 1977).

The Indian harriers were using at least two pre-roosting areas of bare, flat, dried mud, separated from the night-roost grassland by *Prosopis chilensis* thickets. Up to 126 harriers (26 January 1993) were counted on the largest of these. Only a proportion of the harriers seemed to be using them, since a constant stream of harriers passed by, heading for the grassland night-roost. The pre-roosting harriers stood facing into the wind, well spread out in loose groups. The mud was generally very flat, but many individual

harriers were noted perching on the slightest lumps projecting from the surface. Numbers built up until about sunset. After sunset, these pre-roosts would gradually disperse, individuals and small groups flying off to the night-roost.

Especially with a good breeze, aerial activity at the night-roost was on two levels. The number of birds 'milling' above the night-roost quickly built up into a mass of up to several hundred birds towering one hundred metres or more above the settling area. At the same time, a significant number was positioned much higher in the sky, using the warm air until well after sunset and then individuals folded in their wings to stoop down to lower levels, criss-crossing each other's flight paths in the sky, to join the roost. Occasionally a separate tight 'carousel' of circling birds would form. The cause of these could not be ascertained at the time, but subsequent observations suggest that they are a mutual warning mechanism alerting birds to predators in the grass. On some evenings the harriers formed up to three groups of birds milling in the air, which roosted in separate parts of the grassland. Settling by hundreds of birds took place quite rapidly at about twenty minutes after sunset and with some hesitation over places, switching of places or displacement of one harrier by another.

The Velavadar harriers dispersed from the roost at an early dawn. By sunrise almost all had gone, principally in flight-lines south to the main post-roost and west to the main cotton fields and shrublands. Male Pallid Harriers (grey males only identified with certainty in the poor early morning light) left in the same direction as the other harriers, but on average a few minutes later than male Montagu's Harriers, and generally at lower altitude.

The largest pre-roosting area was watched on the morning of 31 January 1993 and at its peak, 81 harriers post-roosted on the ground there. They stood around in exactly the same manner as at pre-roost, preening a little and eventually flying off before sunrise. A dispute over food between 3 or 4 individuals was noted, involving some chasing low over the ground.

The African harriers (Cormier and Baillon 1991) are described as arriving at the roost site in the one and a half to two hours up to dusk, the first ones continuing to hunt over the site and settling on mounds or trees to deal with the prey caught, then taking flight to settle a little later. Communal aerial activity is described as the formation of as many as two or three simultaneous carousels of hundreds of birds each night at about 15-20 minutes before dusk as they took flight in alarm, which subsided before the harriers generally took to the air prior to finally settling. No observations of morning dispersal are given.

**Proportions of grey males and dark morphs:** Cormier and Baillon (1991) recorded only 11% grey males in Senegal, but made the point that this was probably the result of differing preferences of males and females for certain wintering areas. At Velavadar, I recorded an average of 30.5% adult grey males, Montagu's and Pallids combined, from counts ( $n = 11$  counts, 397 birds in total) at the pre-roosts. Successive counts were made at each pre-roost to attempt to average out the effect of any difference in arrival and departure times of the sexes. For example, on 26 January 1993 at 1807 hours there were no grey males out of 16 birds, but 17 out of 35 birds at 1841 hours. On the January 1993 visit, I noted that a few of the juvenile Montagu's harriers present showed signs of moult into adult male plumage with grey heads, throats and upper breasts. To my knowledge, just one dark morph harrier has been seen at Velavadar — a totally dark brown female Montagu's Harrier observed once in flight towards the roost in January 1993 (R. Naoroji, pers. comm.). This is in contrast to the situation in Senegal where 5% of the Montagu's Harriers present were dark morphs (Cormier and Baillon 1991).

**Foraging behaviour:** The great majority of harriers observed foraging over the cotton fields close to Velavadar were Montagu's Harriers. Each one hunted intensively and alone over a field or two, flying 3-4 m above the crop looking down into it for locusts. The locusts were not swarming and I had to search through the crop intently to see any. Strike rate success was casually assessed as on average once every 10-15 minutes. Strikes were usually a feet-first descent with

wings upraised, but shallow stooping was observed once. The rows of cotton plants were about 1m apart and the harrier would momentarily disappear amongst them. After a successful strike, they flew with the locust held firmly at each end, clearly visible in lowered talons and sometimes in tandem much in the manner of an Osprey *Pandion haliaetus* carrying a fish. To eat the locust, they flew to an open piece of ground such as a ploughed field or a trackway. Occasionally they fed on the locust in flight, bill and talons being brought together to meet, in the manner of a Hobby *Falco subbuteo* feeding on insects. There was a lull in hunting activity during the heat of midday, when the harriers tended to circle up in the sky in ones and twos.

The few harriers I saw on the Velavadar grassland during the day were adult male and juvenile Pallid Harriers. They mostly hunted earlier and later in the day, but also at midday if it was overcast. Whilst it was warm, they flew slowly into the wind with 3-4 shallow flaps between each glide, then turning to drift quickly downwind, and repeating. In early morning and evening I saw fast low-level flight, with agile swerves at small birds, reminiscent of the fast, low bird-hunting flight mode of the Hen Harrier (Wassenich 1968). One stoop at potential bird prey on the ground from a few metres height was observed (an unsuccessful strike). I saw one of the adult male Pallid Harriers in fast, determined level chases of small birds that he had flushed or missed on a strike, clearly with some expectation of success.

#### PELLET ANALYSIS RESULTS

The principal prey in the pellets from both continents (Tables 1 and 2) were locusts, in Senegal predominantly the Desert Locust *Schistocerca gregaria*, and in Gujarat the Tree Locust *Anacridium rubripinum*. Locusts featured in 97% of African pellets and 60% of Indian pellets respectively. In the African pellets, Cormier and Baillon (1991) found that ovipositor valves of female locusts greatly outnumbered mandibles. They commented that the male sub-genital plates were difficult to detect and

TABLE 1  
PELLETS CATEGORISED BY PREY CLASSES

	Gujarat		Senegal*	
	n pellets	%	n pellets	%
Locust only	54	40	84	74
Locust & bird	6	4	3	3
Locust & mammal	8	6	21	18
Locust & reptile	9	7	2	2
Locust, bird & reptile	3	2		
Locust, mammal & reptile	1	1		
'Absence of locusts'			3	3
Bird only	32	24		
Bird & mammal	3	2		
Bird & reptile	6	4		
Bird, mammal & reptile	2	2		
Mammal only	8	6		
Mammal & reptile	2	2		
Total	134		113	

\* Cormier & Baillon (1991).

so females greatly predominated in the analysis, although they give no hard figures. Only females could be identified in the Indian pellets, since no male sub-genital plates were evident. However, pairs of mandibles usually substantially outnumbered the count of females in pellets, based on ovipositor valves, contrary to the African results.

Cormier and Baillon (1991) concluded that the harriers in Africa often did not eat the heads of locusts, preferring the content of the abdomen. The predominance of mandibles in the Indian pellets suggests that this was not the case in India. However, remains collected from one 'plucking' place consisted mainly of wings representing about 6 locusts, 5 pronotums, 7 whole and 3 part hind-legs femurs (6 with the rest of the leg attached), and 3 heads. All remains were that of Tree Locusts apart from one Black-spotted Grasshopper *Cyrtacanthacris ranacea* hind-wing.

Of the bird prey, larks could not be identified to species. Pigeons and doves identified in the pellets included Blue Rock Pigeon *Columba livia*, Collared Dove *Streptopelia decaocto*, Little Brown Dove *S. senegalensis* and Green Pigeon *Treron phoenicoptera*.

TABLE 2  
PREY IDENTIFIED IN INDIAN AND AFRICAN PELLETS

	Gujarat n	Senegal* n
Desert Locust <i>Schistocerca gregaria</i>		1355
Tree Locust <i>Anacridium rubripinum</i>	614**	
Other locusts or grasshoppers		
India — Black-spotted Grasshopper <i>Cyrtacanthacris ranacea</i>	68**	
Africa — ( <i>Acrida</i> sp.)		167
Other insects (mostly Coleoptera)		55
Birds		
Larks	47	
Pigeons and doves	7	
Sparrows <i>Passer</i> spp.	4	
Unidentified	18	5
Mammals		
Indian Bush Rat <i>Golunda ellioti</i>	12	
Rat <i>Rattus</i> spp.	2	
Mouse <i>Mus</i> spp.	1	
Indian Gerbil <i>Tatera indica</i> ***	3	
Indian Hare <i>Lepus nigricollis</i>	1	
Unidentified	6	23
Reptiles		
Agamas		2
Unidentified — number of pellets containing remains (unquantifiable as to number of individuals)	23	

\* Cormier & Baillon 1991.

\*\* Total count of 682 locusts from mandibles, etc. (see Methods) apportioned according to the ratio of the pronotums of the two species found in the pellets (209:23).

\*\*\* Possibly Indian Desert Gerbil *Meriones hurrianae*.

## DISCUSSION

The Senegal roost materialised in response to the largest explosion in the population of the Desert Locust in the area for 20 years, with large swarms south of Dakar. In contrast, the Velavadar roost has been known since 1984 (S.Rooke, pers. comm.) and has recurred each winter. The economic value of such roosts can be measured firstly in terms of the number of locusts eaten and secondly in their wildlife tourism potential. A tentative calculation of the number of locusts taken from the surrounding fields by the Velavadar roost in each of the winters might be based

on an average of 750 harriers (mean from pattern of nil at beginning, 1500 peak, nil at end) for 182 days (October to March) consuming 10 locusts on average (calculated from 682 locusts /134 pellets in my sample = 5 x say 2 pellets per day) = 1.365 million. This can be regarded as an underestimate, since the pellet analysis probably significantly undercounts the number of locusts eaten because some heads are discarded and locust pellets disintegrate faster probably reducing the number collected. Calculated another way, 750 harriers on average x 75% (Montagu's Harriers) x 182 days x 2, 2-hour hunting sessions producing 8 locusts each (one every 15 minutes) = 1.64 million. Without further research these figures are crude estimates, but the true figure is probably in excess of 1.5 million. This is one measure of the worth of a protected grassland.

Five locusts were caught in the cotton fields close to Velavadar by M. Pai, three of which were Black-spotted Grasshoppers and two Tree Locusts. Despite the tiny sample, this was a surprising result in view of the scarcity of the Black-spotted Grasshopper in the harrier pellets and prey remains examined (about 10% of locusts). It begs the questions: 1. Were more of the boldly-patterned creamy-yellow and black Black-spotted Grasshoppers caught because they are more obvious to the human eye than the uniformly greyish-pink Tree Locusts? or 2. Do the harriers select Tree Locusts — either for palatability or for ease of capture? Further research is required to answer these questions.

The broader food niche of the Velavadar roost is of course to be expected because of the range of harrier species there. Considering the Senegal results, it might be assumed that the pellets of locust remains at the Indian roost were mainly those of the Montagu's Harriers present, and this could be largely correct. Observation of the birds leaving the roost in the morning emphasised the difference in the flight actions of at least the males of the two principal species. The Montagu's Harriers were able to leave at an early dawn, intermittently flapping gently and gliding out towards the croplands on their relatively larger wings, whereas the Pallid Harriers left later and at lower altitude. Schipper (1977) found that

Montagu's Harrier ranged further from the nest than other species of harrier sympatric with it in western Europe and obtained enough return for hunting effort from smaller prey. This appears to be because of its light wing loading (Nieboer 1973). Locust prey therefore suits Montagu's Harrier well despite its small size and its quantity provides the biomass necessary to attract maximum number of birds to one area. This was not only the case at Velavadar and in Senegal, but 'grasshoppers' were also the principal prey when Montagu's Harriers roosted in thousands in France in the nineteenth century (Barbier Montault 1838).

I suspect that the Pallid Harriers took the largest share of bird prey at Velavadar. The Pallid Harrier is larger than Montagu's Harrier. It exhibits a greater degree of reversed sexual size dimorphism, has proportionately larger feet and claws, and shorter but proportionately more tapered wings (Nieboer 1973). These adaptations point to feeding on birds. Size dimorphism is generally greater in bird-eating raptors (Newton 1979) and larger feet assist in grasping manoeuvrable prey. The slimmer wing structure of the Pallid Harrier favours swifter flight for chasing birds. There is relatively little information on the diet of the Pallid Harrier on its breeding grounds in the steppes of western and central Asia. Early information indicated that the majority of breeding season food was small mammals (80% according to pellets analysed — Osmolowskaja in Glutz von Blotzheim *et al.* 1971), but birds have recently been found to constitute an important part of the breeding season diet, especially when rodents are scarce (Davygora and Belik 1994).

Apart from larks, the Velavadar grassland itself appeared to hold little prey for the harriers. This is in contrast to the situation in Andhra Pradesh (southeast India), where Rahmani and Manakadan (1986) found grasshoppers so abundant that they flushed a few at every step, and 'during the day, fifty to sixty harriers... tirelessly quartering the grassland' at a roost of 800-1000 harriers (mainly Montagu's) in the 1985-86 winter. Similar findings were made by Satheesan and Rao (1990) who identified both large and medium-sized grasshoppers consumed.

The Marsh Harrier is the largest species of harrier, with the shortest wings and tail relative to body size (Nieboer 1973), and so some of the larger prey items in the Indian pellets, such as hare, might be attributed to them.

The occurrence of Hen Harriers at the Indian roost shows, for a few individual birds, that the species' distribution extends south of that quoted in Ali and Ripley (1978).

Further work to be done on harrier roosts in India should include an assessment of pesticide ingestion by harriers, especially in view of the importance of such a large number of harriers to the Asian breeding population. It is possible that they acquire organochlorines in parts of India which affect their success on breeding grounds. Montagu's Harrier is under threat in many areas of the western part of its breeding range. This makes the gaining of an understanding the eastern component of the world population all the more urgent. The status of the more easterly-biased world Pallid Harrier population is not well known, although recent information suggests that the east European breeding population has largely vanished and there may have been some shifting of the range of the Asian breeding population due to major losses of habitat to grazing and agricultural use (Davygora and Belik 1994).

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